Response of *Staphylococcus aureus* to Simulated Microgravity

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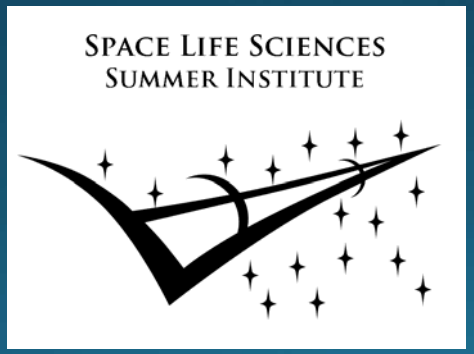

Washington University in St. Louis

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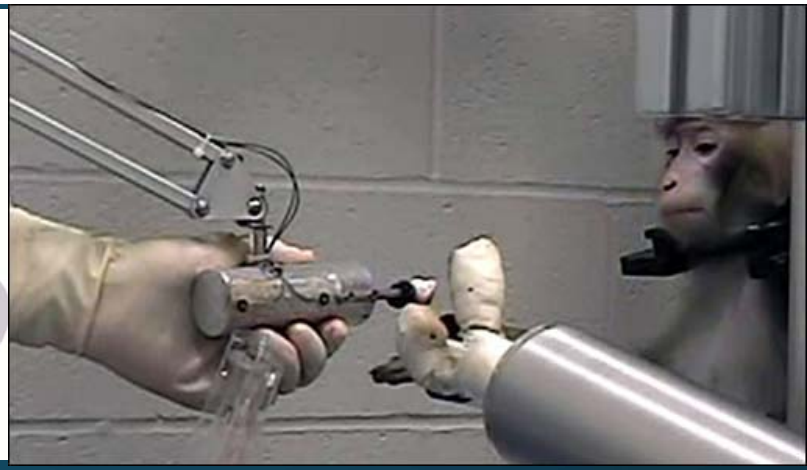

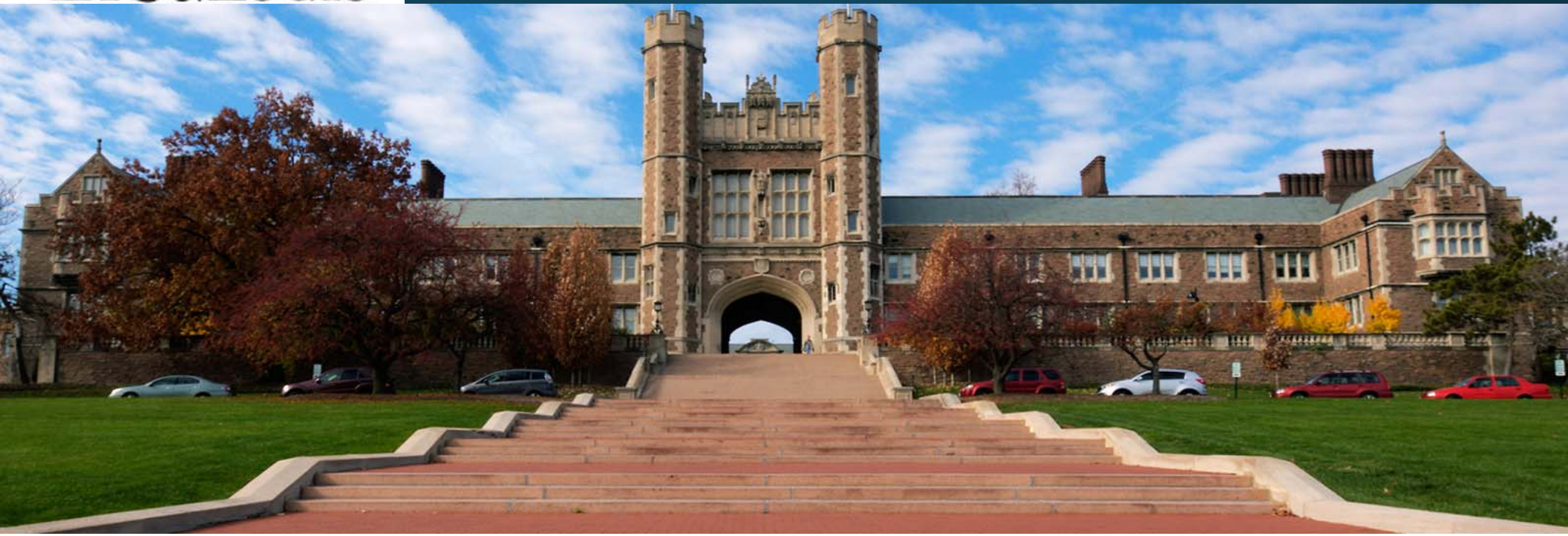

JSC Microbiology Laboratory

Goal: Mitigate microbial risk to crew health, safety, and performance during the human exploration of space

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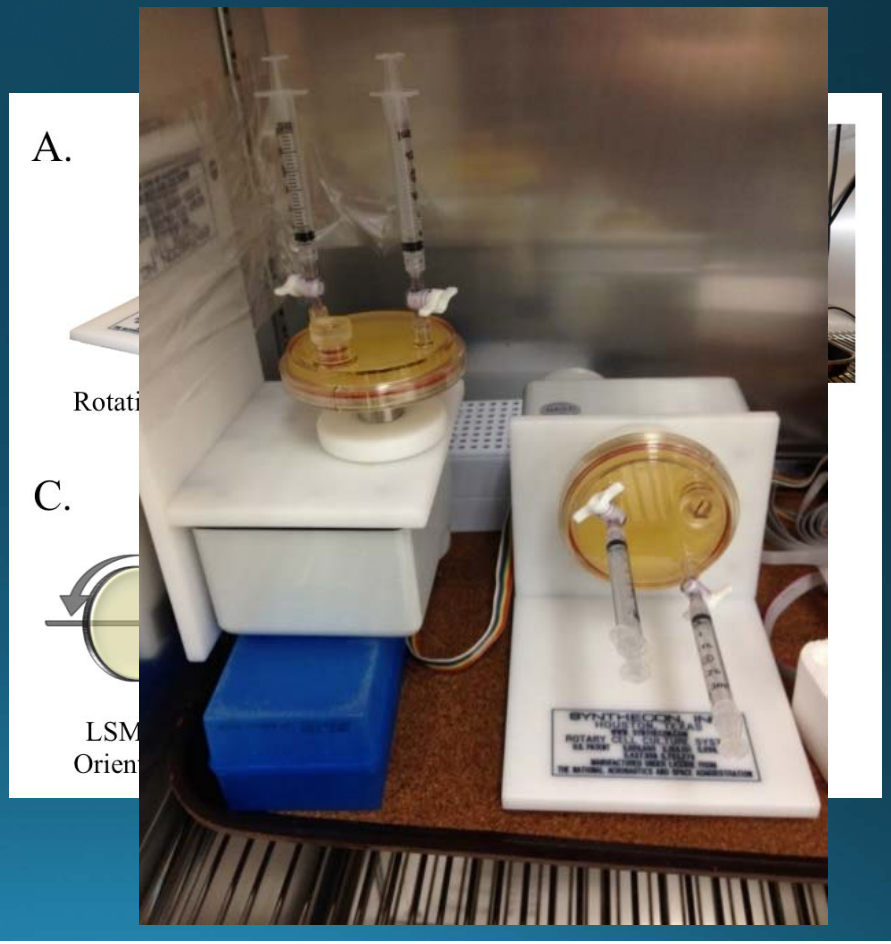
Microgravity Microbiology

- ISS microbiome
- Compromised immune system
- Altered bacterial virulence
- Mutations or expression changes?

Color-enhanced scanning electron micrograph showing Salmonella typhimurium (red) invading cultured human cells. Credit: Rocky Mountain Laboratories, NIAID, NIH

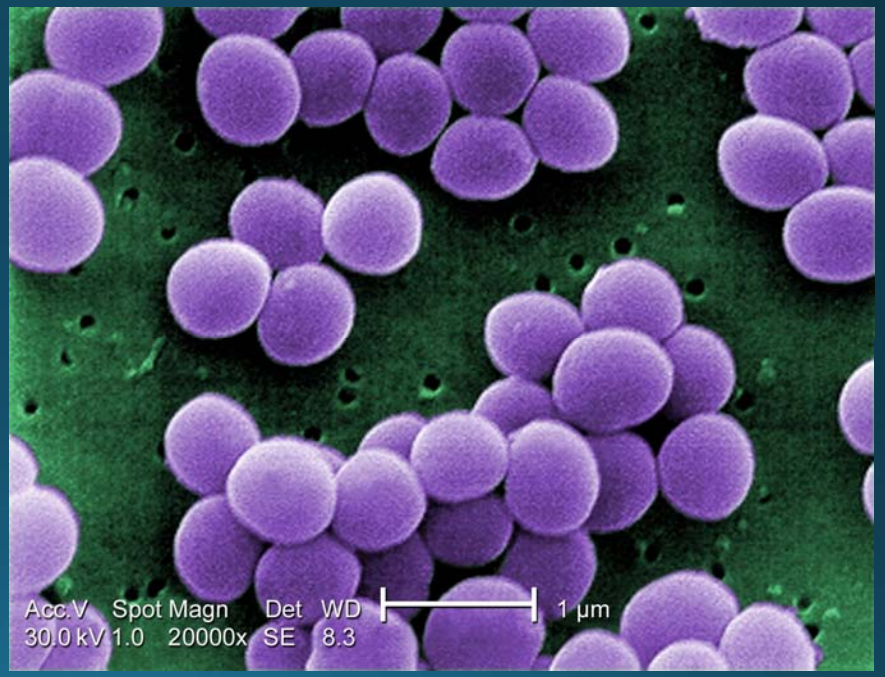
Low Shear Modeled Microgravity

- NASA-Designed Rotating Zero-Head-Space Tissue Culture Vessel
  - Rotating Wall Vessel (RWV)
- Simulated Microgravity
- Used to culture 3D tissue aggregates
- Alters bacterial behavior
  - Attachment independent biofilms
  - Altered virulence

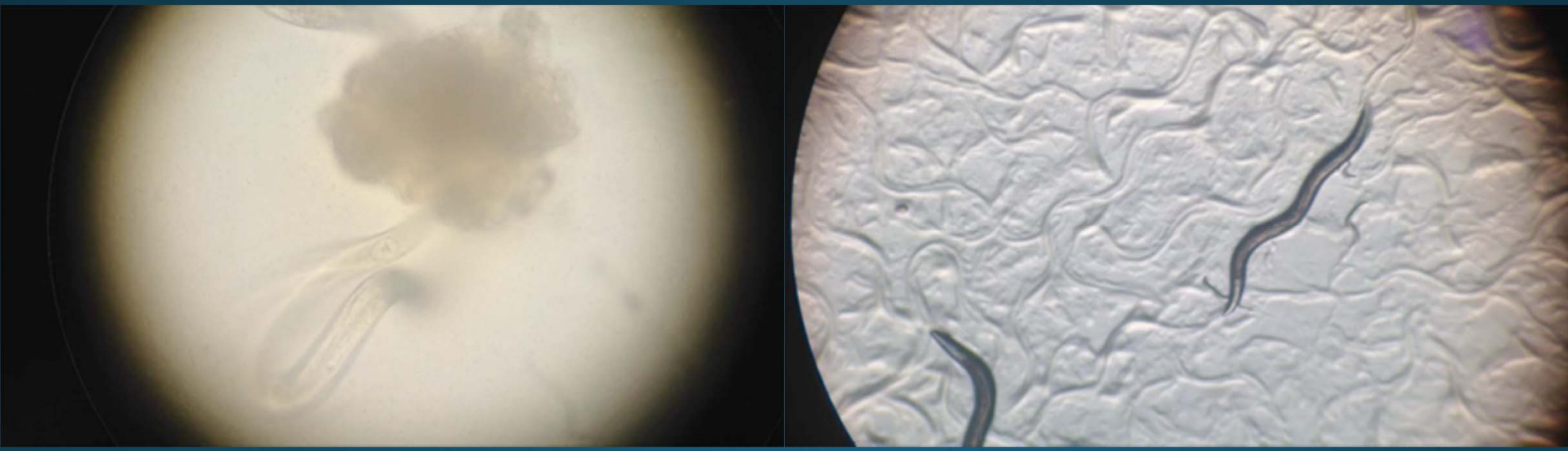


S. aureus

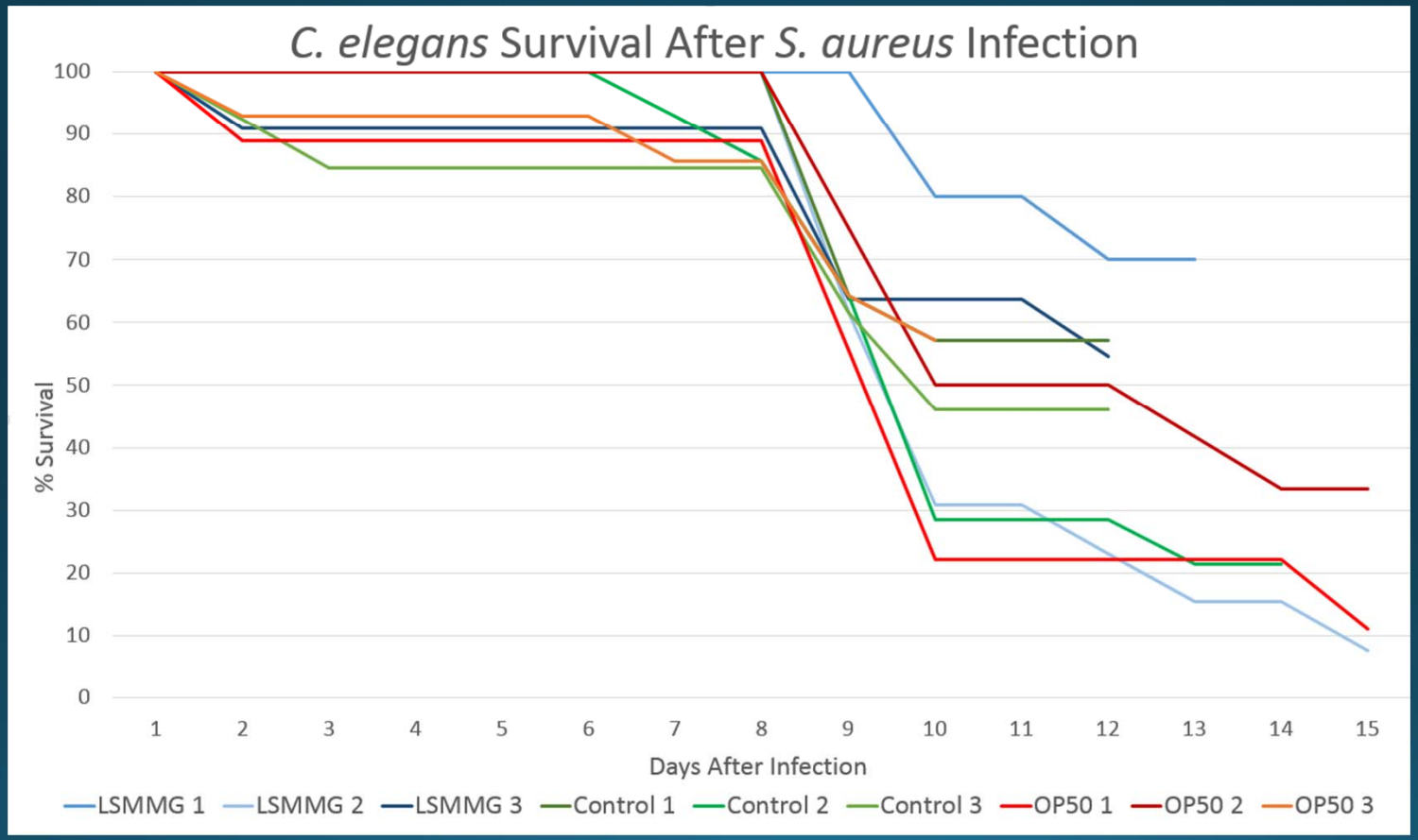
- Opportunistic pathogen
- Common in humans
- Spaceflight isolates/Clinical isolates
- Infection models
  - Mice - skin
  - Nematodes - intestine



Virulence Assay

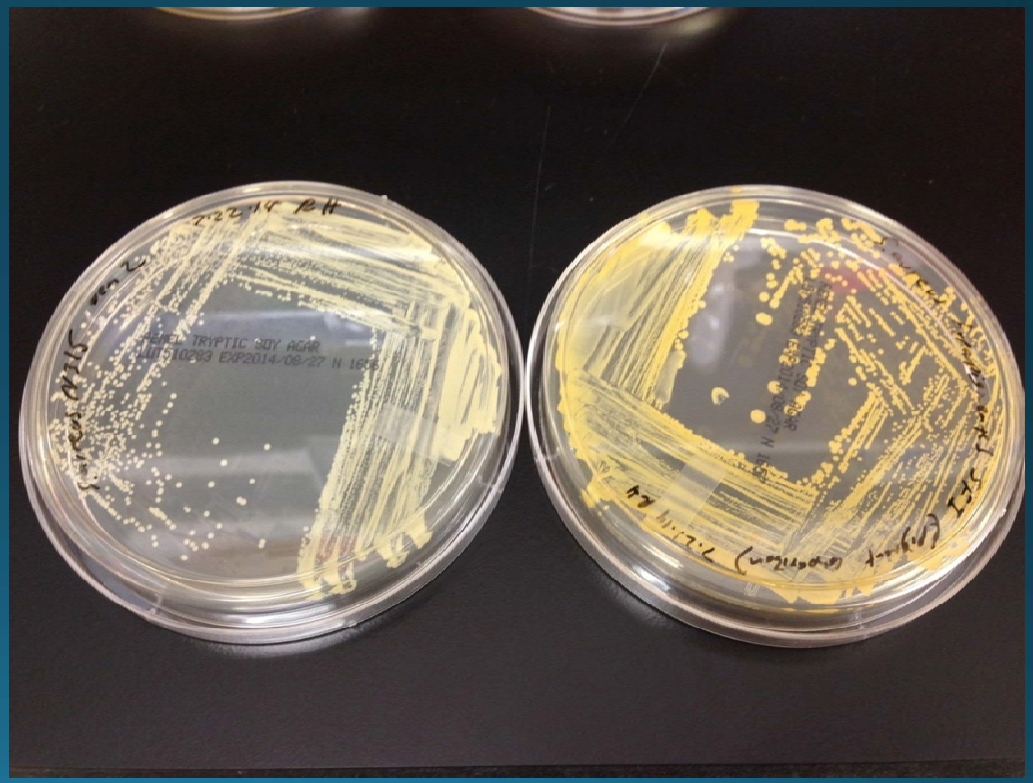


S. aureus N315 clinical isolate (MRSA)


C. elegans Survival After S. aureus Infection
100
90
80
70
60
50
40
30
20
10
0
% Survival
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Days After Infection
LSMMG 1
LSMMG 2
LSMMG 3
Control 1
Control 2
Control 3
OP50 1
OP50 2
OP50 3

Hyperpigmented *S. aureus*

- Spaceflight Isolate
- Increased carotenoid production
- LSMMG comparison between N315 clinical isolate and this strain
  - Biofilms
  - Growth patterns
  - Carotenoid production

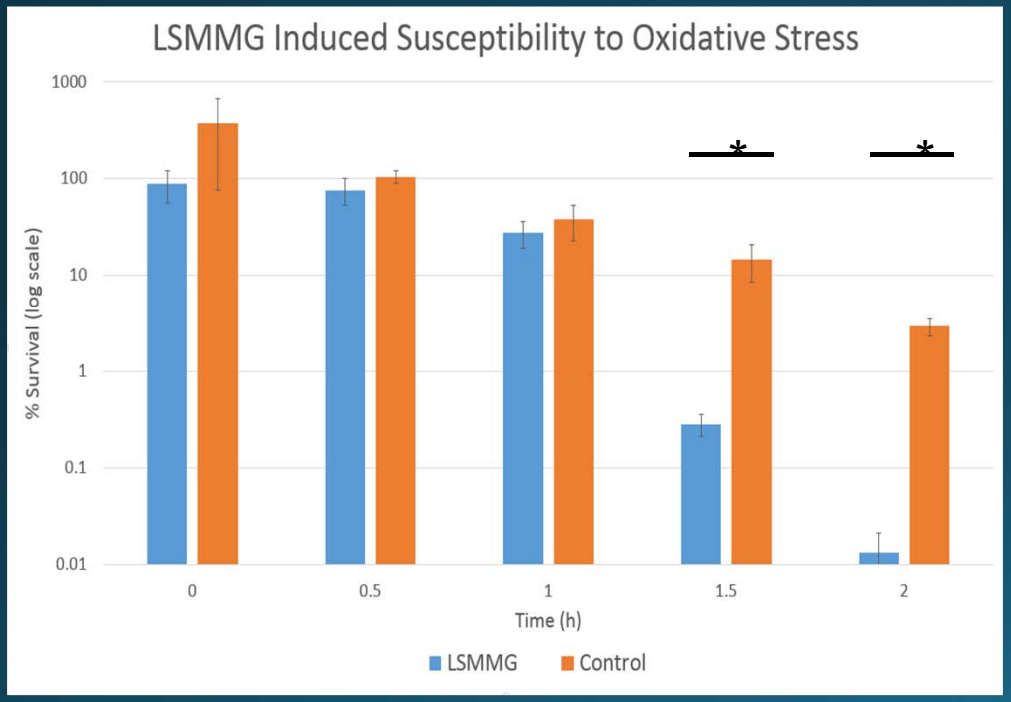


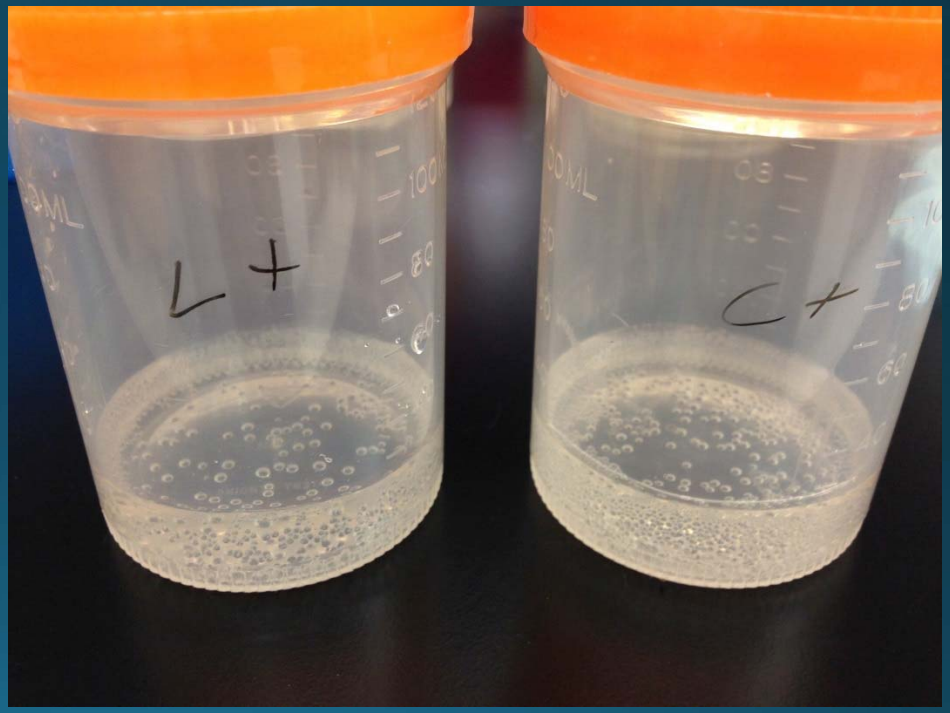
Altered Carotenoid Production

Absorbance at 460 nm			
LSMMG	Control	Ratio	
0.053	0.080	.663	
0.116	0.307	.378	
0.092	0.169	.544	
0.099	0.160	.615	
		Average	.550
		Standard Dev	.125

LSMMG and Control values are statistically significant.
$p < .05$

Oxidative Stress Assays

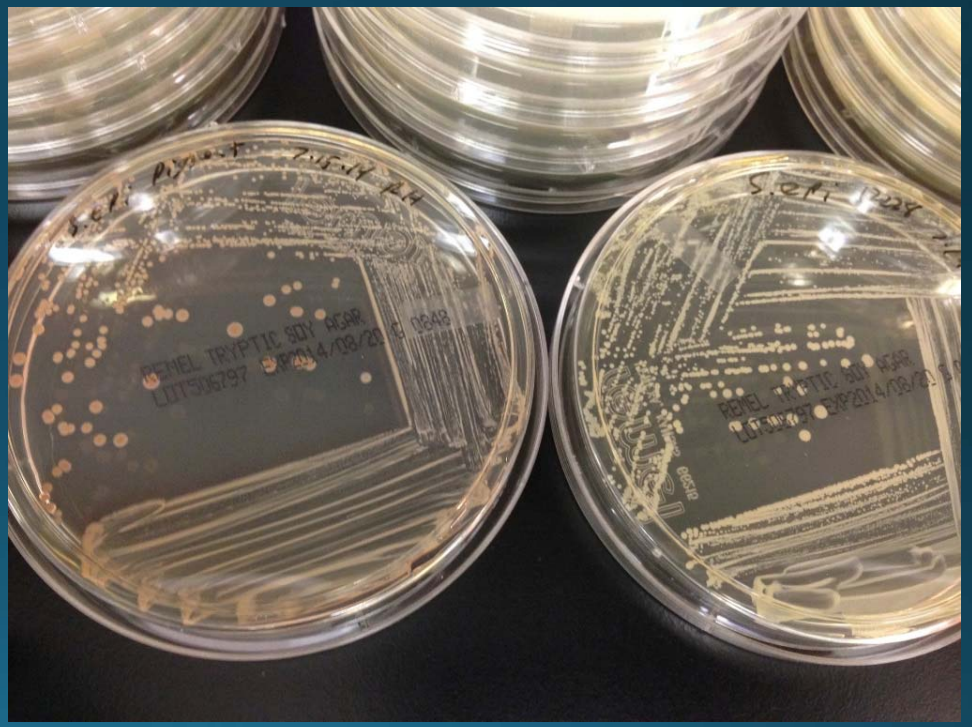




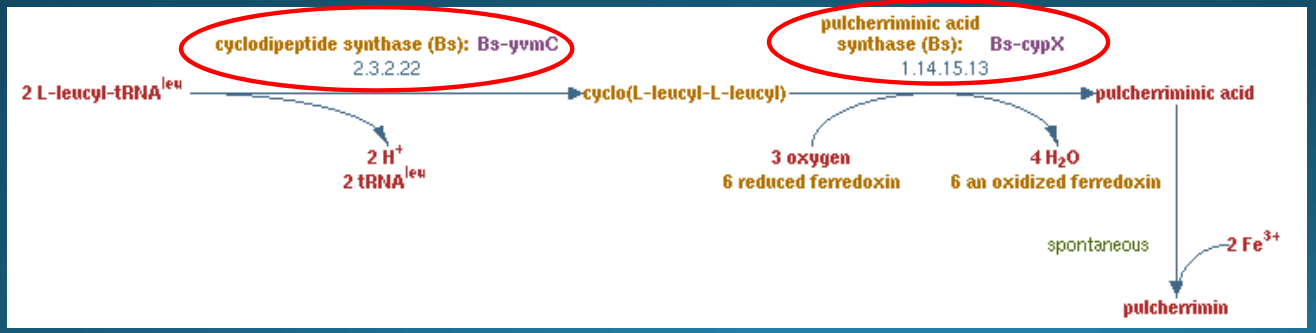
LSMMG induced mutation or just altered expression?

Pigmented *S. epidermidis*

- Spaceflight Isolate
- Possibly the Violagabriellae variant described in the '60s by Marples and Steele
- Unknown pigment molecule
  - Siderophore?



Pulcherrimin Gene Presence



Summary

1. The virulence of *S. aureus* N315 is not significantly altered in response to LSMMG culture, as determined by a *C. elegans* infection model.

2. A hyperpigmented spaceflight isolate of *S. aureus* responds in a parallel manner to LSMMG culture as previously studied clinical isolates.

3. The identity of the pigment displayed by a *S. epidermidis* variant isolated from spaceflight is not known, but potential candidate pigments were ruled out.

Sources

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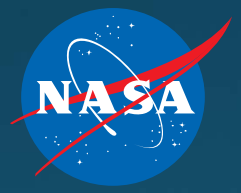
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